

RELATIVE EFFICIENCY OF LOCAL MEAL CONCENTRATE AND PELLETED FEED FOR FATTENING RABBITS IN TROPICAL CONDITIONS. INTERACTION WITH RABBIT'S ORIGIN*

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ABSTRACT : Two-day-old suckling rabbits of a selected strain (NZW) imported from a temperate country (France) were suckled in a tropical country (Benin) by does of the local strain (CECURI). The growth performance of the imported and native rabbits was compared after weaning at 31 days, in a 8 weeks fattening trial. Four groups were constituted: 2 x 24 weanlings of each strain were fed either with the local feed (coarsely ground meal + green forage) or with a balanced pelleted diet imported from France. No morbidity was observed during the trial. NZW and CECURI rabbits had the same growth rate when fed pelleted feed : 29.6 and 28.5 g/day respectively. This performance was only 10 to 22% lower than in temperate countries and the main reason was a lowered feed consumption in relation to temperature. The growth rate of CECURI rabbits fed on the local feed was lower than that of the

group of the same strain fed on pelleted diet. The difference was only 18 % and mainly came from a lower dry matter intake (72.5 vs 84.7 g/day for pellets) The imported strain had difficulties of adaptation not to the climate but to the local feed. His growth rate was only 19.4 g/day vs 23.4 g/day for the local rabbits receiving the same feed. A potential effect of the early chemosensory experience (during both gestation and first suckling) of the imported strain is discussed. In their conclusion, the authors emphasised that neither the climate, nor the feed presentation can explain the very low growth rates (10 to 15 g/day) too frequently mentioned in the literature for post weaning growth experiments conducted with New Zealand rabbits raised in tropical conditions.

RESUME : Efficacité comparée d'un concentré présenté sous forme de farine et d'un aliment complet granulé pour l'alimentation de lapins engraisés en milieu tropical. Interaction avec l'origine génétique des animaux.

Des lapereaux de 2 jours provenant d'une souche sélectionnée (NZW) dans un pays tempéré (France) furent adoptés dans un pays à climat tropical (Bénin) par des mères d'une souche locale (CECURI). La croissance post sevrage des lapereaux importés et des lapereaux autochtones a été comparée dans un essai d'engraissement ayant duré 8 semaines. Au sevrage, quatre groupes furent constitués: 2 x 24 lapereaux de chaque souche logés par cages de 3, furent alimentés soit avec l'aliment local (farine grossièrement moulue + fourrage vert) soit avec un aliment granulé importé de Toulouse. Aucun phénomène pathologique n'est survenu pendant l'expérimentation. Les lapins NZW et CECURI nourris avec l'aliment granulé ont eu des croissances similaires: 29,6 et 28,5 g/jour respectivement. Celles-ci ne sont que 10 à 22% inférieures à celles obtenues en France avec des aliments de même type et la cause de cette diminution est essentiellement une sous consommation alimentaire liée à la température.

Les lapins de la souche CECURI nourris avec l'aliment local ont eu une croissance inférieure de 18% à celle des animaux de même souche nourris avec l'aliment granulé; cette différence provient principalement d'une consommation plus faible de farine : 72,5 vs 84,7 g/jour pour le granulé. Les lapins de la souche NZW ont eu des difficultés d'adaptation, non pas au climat, mais pour consommer la farine ; il en est résulté une croissance plus faible : 18,4 vs 23,4 g/jour pour les lapins locaux recevant la même alimentation. Parmi les hypothèses évoquées, la sous consommation enregistrée pourrait être une conséquence à long terme de l'expérience chimio-sensorielle acquise par les lapereaux NZW pendant la gestation ou lors de la première tété. Dans leur conclusion, les auteurs soulignent que ni le climat, ni la présentation de l'aliment ne peuvent expliquer les croissances très faibles (10 à 15 g/jour) décrites pour des lapins de type neo-zelandais dans de nombreuses expériences réalisées en milieu tropical et publiées dans la littérature.

INTRODUCTION

Most of the reports concerning raising of rabbit in hot climate reveal lower performance than in European countries (OWEN, 1978, EHIÖBU *et al.*, 1997). The most frequent explanation is the negative effect of temperature on feed intake (SAMOGGIA *et al.*, 1987; MARAI *et al.*, 1991, CERVERA *et al.*, 1997). Nevertheless, very low growth rates are frequently observed with New Zealand White rabbits in different experiments conducted under tropical climates *i.e.* 12 to 14 g/day in Nigeria (SESE and BEREPUBO, 1996) or 8 to 10 g/day in India (CHAUDHARY *et al.*, 1995) and

these very low performance cannot be related only to temperature.

At least four main reasons could explain these very low performance, separately or together:

- the climate (temperature + hygrometry + wind etc...),
- the local conditions of management (equipment, professional knowledge, ...),
- the genetic potentialities of the rabbit strains employed, even if in quite all cases the rabbits are said to be « New Zealand White
- and the quality of the feed employed, despite a gross composition in good accordance with recommendations

* One part of these results was presented during the 6th World Rabbit Congress in Toulouse (9-12 July 1996).

Table 1 : Ingredients and gross composition of the coarse meal concentrate employed in the CECURI unit and composition of the palm tree leaves (MEAL feeding)

List of ingredients of the Meal		Chemical composition (%)		
		Meal	Palm leaves	
		Dry matter	94.2	36.1
		%Dry matter		
Maize	14.0 %	Minerals	7.6	5.8
Wheat bran	50.0 %	Crude protein	18.7	16.0
Brewer's grains	30.0 %	Crude fibre	10.1	37.5
Soya meal	4.0%	ADF	12.2	
Oysters shells	1.6 %	NDF	35.2	-
Salt	0.4 %	Ether extract	4.5	2.6

Table 2 : Ingredients and gross composition of the imported complete pelleted feed (PEL)

List of ingredients		Chemical composition (%)	
Wheat	10.00 %	Dry matter	87.8
Barley	1.65 %	%Dry matter	
Wheat bran	21.45 %	Crude proteins	18.5
Alfalfa dehydrated	34.98 %	Crude fibre	17.2
Sunflower meal	12.10 %	ADF	20.5
Spring smooth peas	4.00 %	NDF	36.2
Sunflower seeds	3.50 %	Ether extract	4.6
Wheat straw	4.80 %	Minerals	10.3
Cane molasses	5.00 %	Calcium	1.8
Minerals & Vitamins	2.52 %	Phosphorus	0.7

In order to analyze the contribution of some of the genetic and nutritional factors, we planned a trial in the rabbit breeding facilities of the *Centre CUNicole de Recherche et d'Information (CECURI)* in Benin. The aim of the study was to compare with a 2 x 2 factorial experimental design, the growth performance after weaning of local African rabbits with an European selected strain, using a local feed or an imported balanced diet.

MATERIAL and METHODS

Animals and Housing

Eighty young rabbits, born in Toulouse (France), were imported in Benin when 2 days old and then fostered by local does (CEC rabbits) in the experimental unit of the CECURI. The strain of the imported rabbits labeled NZW in the following text (A 1077 - issued from New Zealand White rabbits) was selected at the *Institut National de la Recherche Agronomique (INRA)* Centre of Toulouse for reproduction traits (ROCHAMBEAU *et al.*, 1994). Each doe adopted 3 imported sucklings and kept 3 of her own progeny. Up to weaning, at the age of 31 days, the does

in the CECURI experimental unit twice a week. The leaves were harvested 3 times a week and stored in a fresh building until utilisation.

and their litters were fed a concentrate coarsely ground (table 1) and green forage in the form of palm tree leaves (KPODEKON *et al.*, 1998). At weaning, 48 imported rabbits and 48 native rabbits were selected for the fattening experiment.

The experimental unit was open-sided, and equipped with wire mesh cages in flat deck (KPODEKON and COUDERT, 1993). Each cage had a metal feeder, and an automatic watering system. The weanlings were raised in a room different from that of the does. Hygienic prescriptions were strictly respected and prophylactic treatments were regularly used against coccidia (ADEHAN *et al.*, 1992) and intestinal worms.

Feeding and drinking

The 2 types of feed studied were distributed *ad libitum* and water was always available with automatic drinkers.

The local feed, called MEAL in the present paper, was constituted of the coarsely ground meal previously mentioned (table 1), distributed with palm tree leaves. The meal was prepared

The second diet was a commercial pelleted feed imported from France (INRA Toulouse) and labelled PEL in the following text (table 2). To exclude any problem of conservation before the experiment, the necessary amount of the pelleted feed was transported by plane from Toulouse to Cotonou and arrived in the experimental unit just before the first utilisation, 10 days after manufacturing.

Experimental design (Table 3)

Groups of animals

The 48 young of each strain (CEC or NZW) selected at weaning were randomly distributed in two groups, and immediately placed in wire mesh cages of 3 rabbits. For each strain, the first group was fed with the local feed and the second one with the imported pelleted feed.

An eventual maternal effect was controlled by using a balanced number of fostered and native rabbits suckled by the same doe. An eventual geographic effect of the situation of the cages in the fattening unit was controlled by distributing the cages into 8 blocs including the four treatments.

Table 3.: Experimental design

	Local meal + forage (MEAL)	Imported pelleted feed (PEL)
CECURI strain (CEC)	5 cages of 3 animals (CEC-MEAL)*	8 cages of 3 animals (CEC-PEL)*
Imported strain (NZW)	8 cages of 3 animals (NZW-MEAL)*	8 cages of 3 animals (NZW-PEL)*

* names of the four treatments in the text

Measured variables

Rabbits were weighed individually at 31 days and then every week until the age of 87 days.

The feed intake was measured on the cage basis in the following ways and calculated for each experimental week.

- Meal: the feeders were filled and weighed every day. The wasted meal was collected under each feeder and weighed. Then the daily consumption was calculated.
- Forage: fresh forage was weighed and distributed every day. On the following day the remaining forage was weighed and consumption calculated. There was no wasted forage. The spontaneous loss of weight of the forage due to desiccation was taken in account.
- Pelleted feed : the feeders were filled and weighed every week. The wasted pelleted feed was collected and weighed and the consumption was calculated.

All results of feed intake and feed conversion ratio were expressed in dry matter (103°C during 24 hours).

During the last week of the experiment, total faecal output was collected during 5 consecutive days, under 4 cages of each treatment. The pooled faeces corresponding to each treatment were dried during 24 hours at 80°C before storage. Dry matter (DM)

digestibility of the feed intake (pellets or meal + forage) was estimated from the DM intakes and DM faecal output. As for feeds, the final DM determination of faeces was obtained after drying 24h at 103°C.

Statistical analysis

The data study was made by

variance analysis with the General Linear Procedure of the SAS-STAT package (SAS, 1988). The employed model included 3 factors (strain, type of feed and blocs) and the strain x feed interaction. When necessary, the means of the 4 experimental treatments were compared with a t test on the basis of the least square means.

RESULTS

Morbidity

No disease occurred during this period. Controls of coccidia were regularly done on faecal samples. The oocyst output was always low and no treatment was undergone. Two animals of NZW-MEAL treatment died (days 55 and 76) and two others of the same treatment were culled (broken leg). Then the results of this group were calculated on the basis of the 20 rabbits alive at the end of the experiment, after taking in account of the feed intake of the disappeared animals.

Weight and weight gain (Table 4 and Figure 1).

At the beginning of the experiment (day 31) imported animals had a significantly lower weight than the native ones, as a consequence of differences in growth observed during the end of the suckling period.

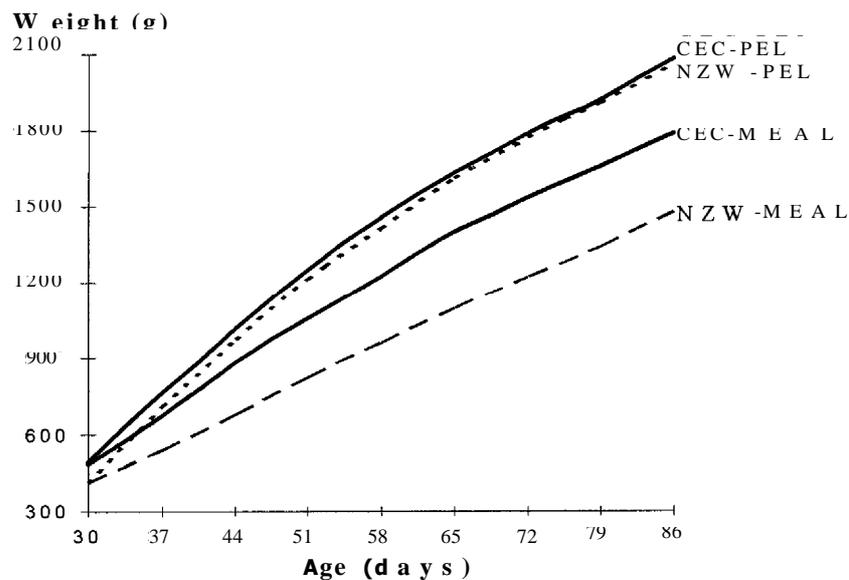
At the end of the experiment (day 87) rabbits of the

Table 4 : Growth performance of rabbits according to rabbits origins and the type of feeding

Groups* strain - diet	No of rabbits	Daily Weight Gain (g)				Final weight at 87 days (g)
		Initial weight at 31 days (g)	31 to 52 days	52 to 87 days	31 to 87 days	
CEC - MEAL	24	482 a	27.4 b	21.0 b	23.4 b	1794 b
NZW-MEAL	20	412 b	19.5 c	19.4 b	19.4 c	1485 c
CEC - PEL	24	494 a	36.1 a	23.9 a	28.5 a	2090 a
NZW - PEL	24	413 b	38.1 a	24.4 a	29.6 a	2069 c
<i>Residual Coef. of Variation (X)</i>		16.4	14.7	14.7	9.7	9.0
Probability of	Strain	0.0001	0.0031	ns	0.0039	0.0001
Effects	Diet	ns	0.0001	0.0001	0.0001	0.0001
(P)	Strain x Diet	ns	0.0001	0.0829	0.0001	0.0002

a, b : in the same column, means with the same letter are not different at P = 0.05 ; ns = non significant (P > 0.10)

* CEC = local strain of the CECURI (Benin); NZW = imported strain of Toulouse (France); MEAL = local feed (CECURI); PEL= imported pelleted feed

Figure 1: Evolution of the weight of two origins of rabbits fed the two types of feed.

two treatments fed on the imported pellets, had a similar growth performance regardless of the strain. In addition, the daily weight gain (DWG) was significantly higher in the pellets fed groups than in the two groups fed with the local feed (CEC-MEAL & NZW-MEAL) ($P < 0.05$).

The growth of rabbits of the two MEAL-fed treatments was not similar. The NZW rabbits had a significantly lower DWG than the CEC ones ($P < 0.05$). This lower DWG in NZW-MEAL treatment was especially pronounced just after weaning. During the first three weeks, the average DWG of the NZW rabbits was 29% lower than that of the local rabbits ($P < 0.001$). During the following 5 weeks, this difference lowered to only 7,6% on average and was not statistically significant.

Feed intake and Feed efficiency (Table 5).

With the meal, daily food wastage was very important and represented up to 30% of the daily distribution. But as an appreciable quantity was remaining in the feeders every morning, the rabbits can be said effectively fed *ad libitum*. In addition, as the wasted meal was collected under the cages, the apparent consumption measured was very close to the real feed intake. With pellets, the wastage was quite negligible when compared to that observed with the meal.

During the whole experiment, the eaten amount of palm tree leaves was independent of the rabbit's origin. But the imported rabbits ate a significantly lower amount (-35%) of meal ($P < 0.05$) and this was observed during the whole experiment. Both groups of rabbits fed on the imported pellets (CEC-PEL & NZW-PEL rabbits) consumed a similar amount of feed. The dry matter intake for these two treatments was significantly

higher than that observed for the two others fed on meal + forage (CEC-MEAL & NZW MEAL) ($P < 0.05$).

On average for the whole experimental period, the dry matter feed conversion ratio (FCR) was the lowest for the imported rabbits (2.71 vs 3.04 - $P < 0.0001$), without interaction with the source of feeding. The feed conversion ratio was similar with the 2 types of feeding (2.89 and 2.86 for the MEAL and PEL treatments respectively). Nevertheless it must be emphasised that during the first 3 weeks of the experiment, the FCR was significantly lower with the pelleted diet (1.81 vs 2.24) and that at the same time, no significant difference was observed between the types of rabbits. During the 5 following weeks, the situation was completely different and the lowest FCR was observed for the NZW-MEAL treatment alone : 2.93 vs 3.72 to 3.97 for the 3 other treatments ($P < 0.001$).

Only one value was estimated for feeds DM digestibility within each treatment. Thus, no statistical analysis was possible. Nevertheless, it must be pointed out that DM digestibility was more efficient for the 2 MEAL treatments (76.8% and 74.2% for the CEC and the NZW rabbits respectively) than for the 2 PEL treatments (68.8% and 68.0% for the CEC and the NZW rabbits respectively). The difference in DM digestibility between MEAL and PEL feeds cannot be related just to a difference in crude fibre content since it was relatively close on average for the 2 MEAL groups (16.2% for the CEC rabbits and 17.9% for the NZW rabbits) and for the pellets (17.2% in DM). On the contrary, the apparent better DM digestibility observed for the MEL-CEC treatment can be related to the lower proportion of forage in the daily intake of the MEAL

Table 5 : Feed intake (g DM/day) and feed conversion ratio (FCR : g DM intake/g of gain) of fattening rabbits according to rabbits origins and type of feeding.

Groups *		Weeks 1 to 3				Weeks 4 to 8				Weeks 1 to 8			
		Dry Matter intake		FCR	Dry Matter intake		FCR	Dry Matter intake		FCR			
Strain diet		meal forage or pelleted feed			meal+forage or pelleted feed			meal+forage or pelleted feed					
CEC - MEAL		49,7 a	11,6 a	61,3 a	2,23 a	60,2 a	19,0 a	79,2 b	3,77 a	56,3 a	16,2 a	72,5 b	3,09 b
NZW - MEAL		33,2 b	9,9 a	43,2 b	2,24 a	38,8 b	17,6 a	56,4 c	2,93 b	36,7b	14,7 a	51,4 c	2,65 a
CEC - PEL				68,0 a	1,88 b			94,7 a	3,97 a			84,7 a	2,97 b
NZW - PEL				66,1 a	1,73 b			90,7 a	3,72 a			81,5 a	2,76 a
Res.Coeff.Var. %		17.2 %	16.4 %	11.0%	7.7%	12.8 %	16.7 %	8.6%	8.7%	12.0 %	14.8 %	7.9%	6.4%
Proba.	Strain	0.0075	ns	0.0006	ns	0.0009	ns	0.0001	0.0001	0.0008	ns	0.0001	0.0001
Effects	Diet	-	-	0.0001	0.0001	-	-	0.0001	0.0004	-	-	0.0001	ns
(P)	S. x D.	-	-	0.0042	ns	-	-	0.0014	0.0202	-	-	0.0005	ns

a, b : in the same column, means with the same letter are not different at P = 0.05; ns = non significant (P > 0.10)

* CEC = local strain of the CECURI (Benin); NZW = imported strain of Toulouse (France); MEAL = local feed (CECURI); PEL— imported pelleted feed

CEC rabbits (*i.e.* lower fibre content), than the proportion observed for the MEAL-NZW rabbits.

DISCUSSION

The average daily growth rate observed in this experiment with feed and rabbits imported from France (29.6 g/day) are reduced by about 10% comparatively to the performance of rabbits of the same strain (INRA 1077) fed with similar diets in Toulouse during the summer time (33.2 d/day in summer and 38.2 g/day in spring ; LEBAS, 1996). As the minimum temperature observed in Toulouse was 20°C in the above mentioned experiment (with a maximum of 29°C) and as minimum temperature was higher in Benin (tropical climate during the dry season: daily minimum of 25-27°C), it can be assumed that the specific effect of climate and mainly of temperature, represents a reduction of growth rate of 10 to 22% according to the European season considered as reference. The growth rate of the local rabbits was insignificantly lower than that of the rabbits imported from Toulouse. Then, the very low growth rates reported in the introduction of this paper *i.e.* 12-14 g/day in Nigeria, a country very near of Benin, (SESE and BEREPUBO, 1996) cannot be related to climate or rabbit strain since the climate was the same and rabbit of NZW origin in both cases. In addition, it was demonstrated that selected (imported NZW rabbits) and non selected CEC rabbits were able to grow at the same speed, if they receive a pelleted balanced diet. Then, the explanation of the low performance published in the literature must be searched mainly in management conditions and/or in

feed quality, since the genetic and climatic effects can be excluded as major factors.

The meal feeding employed in the present experiment induced a reduction of growth rate of 18% of the CECURI rabbits when compared to the imported pellets feeding. This is the exact reduction of growth rate observed some year ago in a meal vs pellets study performed with a common diet's formula (29.7 vs 36.0 g/day) (LEBAS, 1973). Then the effect of the feed presentation in the very low performance mentioned in literature can be also excluded. The remaining explanations are the feed composition (proportion and quality of the ingredients) and the management, but these explanations are only hypothesis.

If the genetic origin of rabbit has no significant effect on growth rate when rabbits received a pelleted balanced diet, the corresponding FCR ratio was significantly lower (better feed efficiency) for the NZW imported rabbits. The apparent advantage of the NZW rabbits employed in this experiment was not related to a more efficient digestion since DM digestibility was the same (68.8% and 68.0%) for the 2 genetic origins. Then the better feed efficiency is most probably related to a more accurate correspondence of the digested fraction with the nutritional requirements of the NZW rabbits than with that of CEC ones.

More interesting is the unexpected low growth rate observed with the NZW imported rabbits fed local meal + forage. Nevertheless this growth rate was clearly higher than the very low values mentioned in the literature. The reduced growth observed in the present

experiment, may be interpreted as a maladjustment of the imported rabbits to local feed. During the suckling period only the local feed was used. KPODEKON *et al.*, 1998 mentioned that the growth of both imported and native sucklings was identical up to the third week of life. But during the fourth week, *i.e.* as soon as the sucklings began to consume the solid feed, the imported fostered rabbits (NZW) displayed a significantly lower growth.

In the present work performed with the same rabbits after weaning, both NZW and CEC rabbit exhibited the same average growth rate, when fed the imported balanced pelleted diet. Moreover, as expected during the first weeks of fattening, the NZW animals compensated for their handicap in weaning weight (Figure 1). Therefore the hypothesis of a genetic maladjustment of the imported strain to the African climate can be discarded.

On the contrary, the other group of imported rabbits fed with the local feed before and after weaning (NZW-MEAL) continued also to show a lower growth than the local strain. The feed efficiency being similar in both MEAL-groups, the only reason seems to be the lowered consumption of meal concentrate. Two hypotheses can be suggested (KPODEKON *et al.* 1998) to explain this lowered meal consumption in the imported rabbits.

- The first considered the possibility of a genetic inability to orally process the coarsely ground meal.
- The second hypothesis suggested the possibility of an effect of the early chemosensory experience of rabbits (BILKO *et al.*, 1994; HUDSON *et al.*, 1994; SCHAAL *et al.*, 1992).

Indeed chemosensory experience gained both *in utero* and during the first day suckling period by the imported animals, may have, at least partially, affected negatively the intake of the feed bearing an unfamiliar. If this hypothesis is correct, the present results (lasting 8 weeks) suggest stable consequences of early perinatal learning on postweaning feed consumption, and hence, on growth during the fattening period. This hypothesis is currently tested by the authors.

CONCLUSION

The present experiment demonstrated that it is possible to obtain under tropical conditions, relatively high growth rate with New Zealand White fattening rabbits (about 29-30 g/day) as well as with other non selected rabbits. The meal presentation of concentrate, frequently employed when a pellet machine is not available, induces a reduction of feed intake and a correlative 20% reduction of growth (23-24 g/day). Then the explanation of the very low growth performance too often described in experiences performed in tropical conditions, is not the effect of high temperature, of the rabbit sensitivity to climatic constraints nor of the feed presentation.

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GROSS PERFORMANCE IN TROPICAL CONDITIONS.

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